CANopen

Hardware Setup Manual

04/2009

35010857.03

www.schneider-electric.com

Schneider Electric

Schneider Electric assumes no responsibility for any errors that may appear in this document. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

No part of this document may be reproduced in any form or by any means, electronic or mechanical, including photocopying, without express written permission of Schneider Electric.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

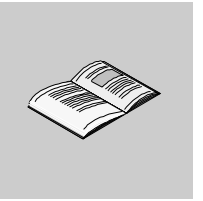
When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

© 2009 Schneider Electric. All rights reserved.

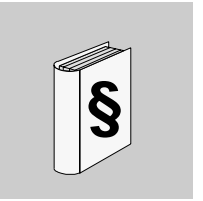
Table of Contents



	Safety Information	**5**
	About the Book	**7**
Chapter 1	**CANopen Introduction**	**9**
	CANopen Principles	9
Chapter 2	**CANopen Network Topologies**	**11**
	General Architecture of a CANopen Network	12
	Basic Topology	13
	Topology with a Repeater	14
	Topology with a Bridge	16
	Cascading of TAPs	17
	Topology with External Power Supply	18
Chapter 3	**Network Design**	**21**
3.1	Installation	22
	Principles	23
	Cable Installation	24
	CANopen In-Cabinet Cabling	25
3.2	Physical Layer Limitations	27
	Transmission Speed and Cable Length	28
	Drop Cable Limitations	30
	Network with External Power Supply	32
	Verifications and Troubleshooting	34
Chapter 4	**CANopen Infrastructure Components**	**35**
4.1	CANopen Cables	36
	CANopen Cables	37
	Cable Types	38
4.2	CANopen Cable Connectors	39
	SUB-D 9 Cable Connectors	40
	Open Style Cable Connectors	44
	IP67 M12 Cable Connector	46
4.3	CANopen TAPs	48
	TSX CAN TDM4	49
	VW3 CAN TAP2	53

4.4 CANopen - Daisy Chain Connector 55
CANopen - Daisy Chain Connector 55
4.5 Preassembled Cord Sets 57
Preassembled Cord Sets 57
Chapter 5 CANopen - Connectors 59
CANopen Device Connector Pinout 59
Glossary 63
Index 65

Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

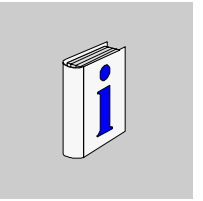
⚠ CAUTION
CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

CAUTION
CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

About the Book



At a Glance

Document Scope

This manual provides basic information on CANopen networks as used by Schneider Electric. It additionally describes the CANopen infrastructure components (connectors, cables, TAPs) provided by Schneider Electric for setting up a CANopen network.

Validity Note

This documentation is valid for CANopen networks as used by Schneider Electric.

Related Documents

Title of Documentation	Reference Number
Electromagnetic Compatibility EMC, Practical Installation Guidelines	DEG999
Machines & Installations with Industrial Communications Catalog (Part 4)	MKTED207012EN

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

CANopen Introduction

1

CANopen Principles

CAN

The CAN (Controller Area Network) was originally developed for onboard automobile systems, and is now used in a wide range of areas, such as:

- transport,
- mobile equipment,
- medical equipment,
- construction,
- industrial control.

The strong points of the CAN system are:

- its bus allocation system,
- its error detection capability,
- the reliability of its data exchanges.

CANopen

CANopen specifies the higher layer protocol and is based on CAN.

Master/Slave Structure

The CANopen network has a master/slave bus management structure and consists of 1 master and 1 or more slaves.

The master performs the following functions:

- initialization of the slaves,
- supervision of the slaves,
- providing status information of the slaves.

Media Access and Topology

The CAN protocol authorizes each node to start transmission of a packet when the bus is inactive. If 2 or more nodes start packet transmission at the same time, the access conflict on the bus is resolved by arbitration using the identifier included in the packet.

The sender with the highest priority identifier obtains access to the bus; the packets of other senders will be resent later on.

This arbitration uses a recessive and a dominant status on the bus, and is executed on transmission of each bit. Each sender tests the status of the bus during transmission of its bits; if a recessive bit is transmitted and the bus is in a dominant state, the sender loses place and transmission stops.

As a consequence of this, during transmission of each bit, a signal sent has the time to propagate until the farthest node, and returns to dominant state. This is why the bus has different length limitations according to the transmission rate.

CANopen at Machine and Installation Level

According to the Schneider Electric network strategy, CANopen is mainly intended for the machine and installation level.

CANopen Network Topologies

2

Subject of This Chapter

This chapter describes the different types of topologies and connections possible on a CANopen bus.

What's in this Chapter?

This chapter contains the following topics:

Topic	Page
General Architecture of a CANopen Network	12
Basic Topology	13
Topology with a Repeater	14
Topology with a Bridge	16
Cascading of TAPs	17
Topology with External Power Supply	18

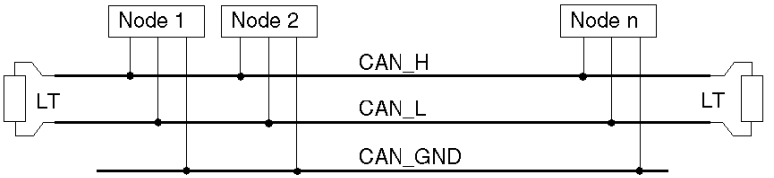
General Architecture of a CANopen Network

Overview

The CANopen network uses a twisted pair cable to transmit the differential signals, terminated at both physical ends with 120Ω resistors (LT in the figure below). A separate ground signal is used as a common reference for the CANopen nodes.

Graphical Representation

The drawing below illustrates a general CANopen architecture:



Each Schneider Electric CANopen component allows interconnection of the following signals:

Designation	Description
CAN_H	CAN_H (CAN High) bus conductor
CAN_L	CAN_L (CAN Low) bus conductor
CAN_GND	CAN bus ground

NOTE: In addition to the 3 wires noted above, some Schneider Electric cables provide this feature with a fourth wire for remote power supply to devices.

Basic Topology

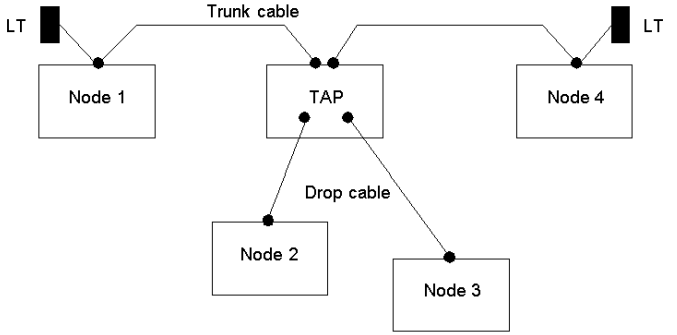
General

The CANopen network consists of a transmission line that must be terminated at both physical ends with termination resistors.

A TAP in combination with drop cables form a partial star topology. In order to minimize reflections, keep drop cables as short as possible. The maximum length of drop cables depends on the transmission speed. For a list of the cable length allowed refer to the Maximum Cable Length table *(see page 28)*.

Example of a Basic Topology

The diagram below provides an example of a basic topology:



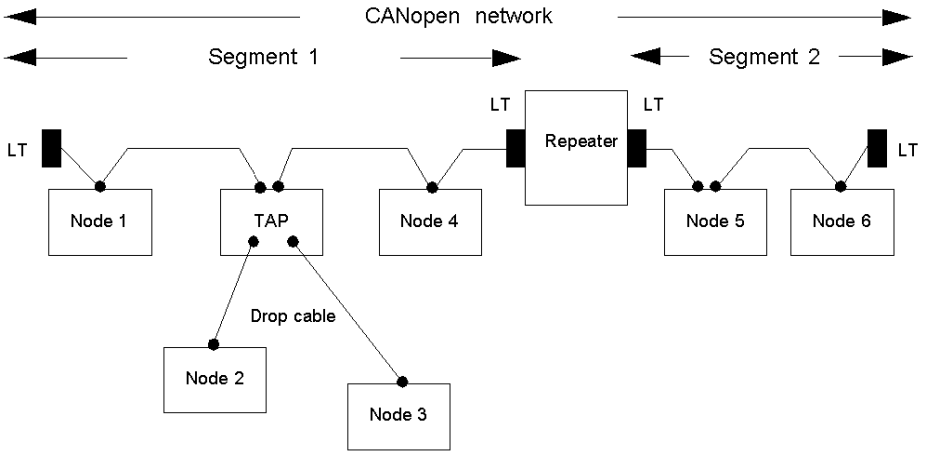
Topology with a Repeater

General

The CANopen network may be comprised of 1 or several segments, physically linked together via a CAN repeater.

Example of a Topology with Repeater

The figure below provides an example of a topology including a repeater:



Repeater Functions

A repeater:

- provides a refresh of the CAN signals, thus allowing more than 64 nodes.
- may provide isolation between the segment. Each of these segments must be terminated.
- is transparent, from the network point of view, because it simply forwards the CAN signals. This means that the devices connected to the bus participate in the same arbitration.
- does not allow to increase the total cable length. For the maximum cable lengths allowed refer to the Maximum Cable Length table *(see page 28)*.

Chaining the Cable

The chaining of the cable from 1 node to the next is performed via the cable connectors in 2 different ways:

- by connecting 2 cables to the same cable connector. This widely used chaining technique allows to disconnect the cable connector from the device (i.e. device replacement) without disruption of the network.
- by connecting the 2 cables to individual cable connectors on devices that provide 2 cable connectors (node 5 in the above example). This chaining technique is used especially on high protection devices (i.e. IP67 devices) or for optimized cabling systems in the cabinet.

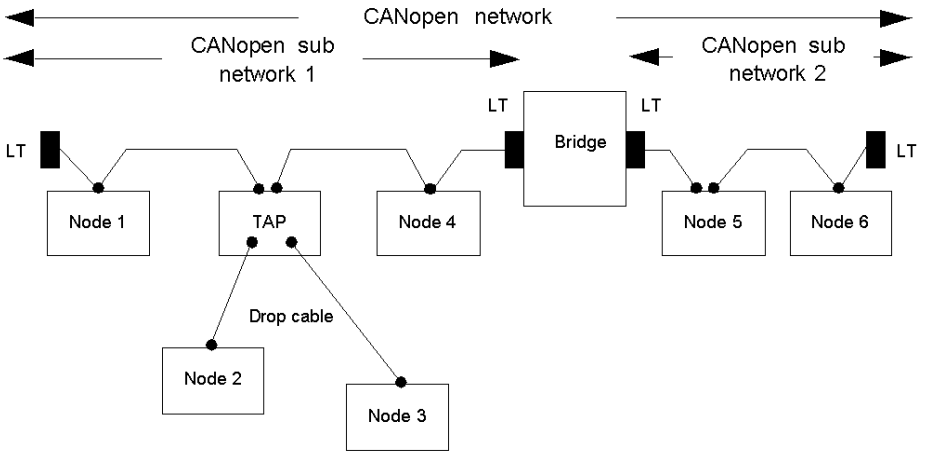
Topology with a Bridge

General

A CANopen overall network can be separated into more or less independent sub-networks via a CAN bridge.

Example of a Topology with Bridge

The figure below provides an example of a topology including a bridge:



Bridge Functions

A bridge:

- separates the overall CAN network into more or less independent sub-networks.
- provides an individual arbitration for each sub-network.
- provides the possibility for each sub-network to have its own transmission speed.
- is based on the store- and forward principle, i.e. CAN messages are received by a sub-network and are then forwarded to another sub-network.
- allows the use of translation and filter rules.
- allows a protocol adaptation to be carried out between the sub-networks.

In contrast to the CAN repeater, the CAN bridge allows to enlarge the maximum network size.

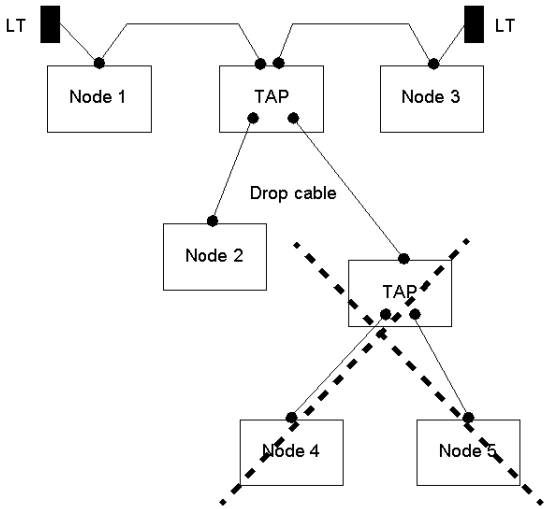
Cascading of TAPs

General

In CANopen networks cascading of TAPs is not allowed as this would harm the transmission line characteristic.

Example of Cascaded TAPs

The figure below illustrates that cascaded TAPs are not allowed in CANopen networks:



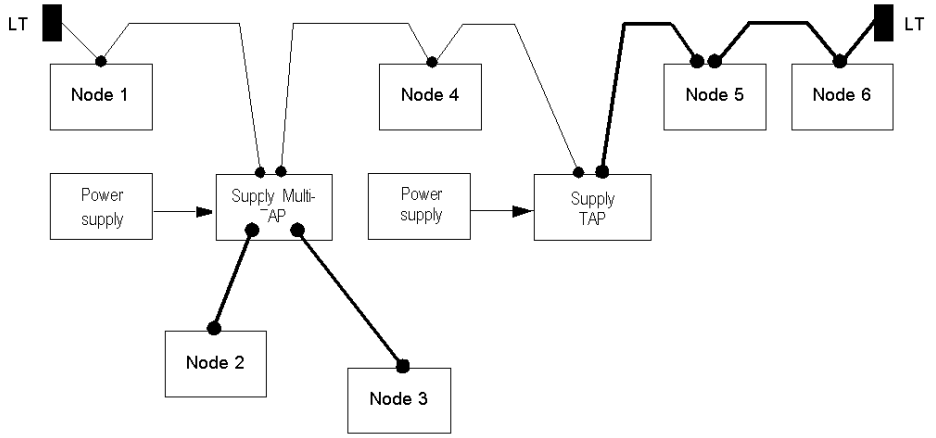
Topology with External Power Supply

General

To provide power to nodes of the CANopen network an external power supply can be connected to a TAP.

Example of a Network with External Power Supply

The figure below provides an example of a topology with external power supplies:



Supply TAPs

There are 2 types of power supply TAPs available:

TAP Type	Function	Powered Nodes in the above Example
Supply Multi TAP	provides the power to the drop cables	2 and 3
Supply TAP	provides the power to the outgoing cable, thus providing power to the following nodes	5 and 6

Power Signals

Power is carried by the signals `CAN_V+` and `CAN_GND`. Since these signals are provided on standard CAN cables, no special cables are required for power supply.

Forwarding Power through the Cable

In order to forward the power through the cable, it is required that the CAN_V+ signal is connected in the cable connector of each node, even if the respective node does not use the power itself but forwards it to a following node.

NOTE: Repeaters, bridges and RJ45 cables do not forward the CAN_V+ signal at all.

For more information on power distribution over the network see section Physical Layer Limitations *(see page 27)*.

Network Design

3

Subject of This Chapter

This chapter lists references to documents describing the rules of network design, it describes the relation between cable length and transmission speed, the limitations on drop cables as well as specifications applying to networks with external power supplies.

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
3.1	Installation	22
3.2	Physical Layer Limitations	27

3.1 Installation

Overview

This section lists basic rules for CANopen networks as well as reference documents that must be considered during installation and includes precautions against EMC.

What's in this Section?

This section contains the following topics:

Topic	Page
Principles	23
Cable Installation	24
CANopen In-Cabinet Cabling	25

Principles

Overview

Carefully document and record the network design with associated calculations because such documentation will be very useful when planning future changes. It will also help maintain bus performance.

Principles of Network Design

Observe the following rules when designing the CANopen bus:

- assign each node a unique CANopen node address,
- make sure that the nodes in one network have the same transmission speed,
- verify the length of the drops and the density of these drops,
- verify that the segments have a termination resistor connected at each extremity.

In any case take the design of the network into consideration and follow the technical rules described in the following sections.

Cable Installation

Overview

The CANopen bus is designed for use inside buildings located in a workshop or factory environment. As for any other industrial buses you must nonetheless follow strict rules for installation to achieve full performance of the bus.

Installation Rule References

Pay particular attention to the rules listed in the Electromagnetic Compatibility EMC, Practical Installation Guidelines *(see page 7)* document.

Shielding and Grounding

To limit common mode disturbances and to achieve a high level of robustness against EMC, take the following precautions:

- Wire a common ground (`CAN_GND`) to the CANopen devices. Together with the electrical isolation this helps to ensure that the CANopen devices are on the same reference level.
- For devices without electrical isolation (consult the device's user manual to find out whether it is isolated) take other measures, like a separate equipotential bonding wire, to help to ensure the same reference level.

CANopen uses shielded twisted pair cables. On each device the shield is connected to functional ground. This is for example automatically achieved via the metal housing of the SUB-D 9 cable connector.

CANopen In-Cabinet Cabling

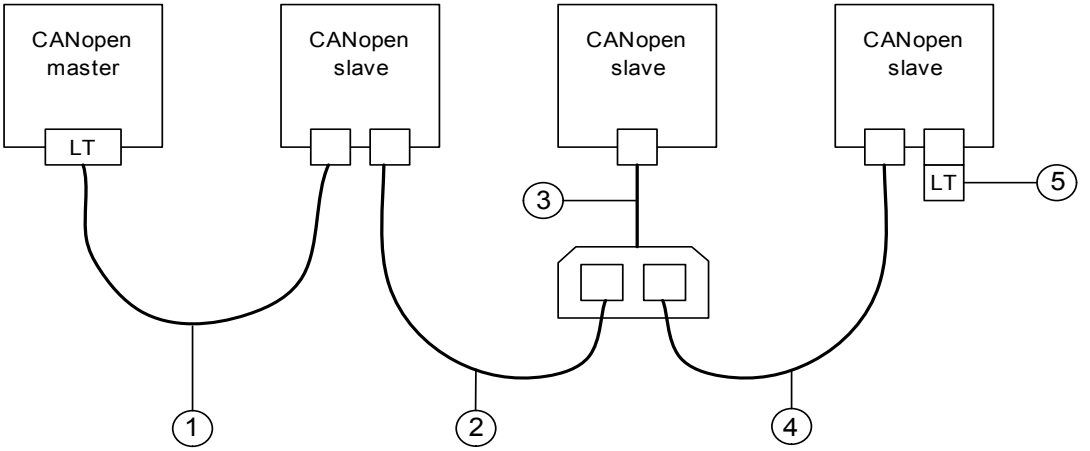
General

Schneider Electric provides preassembled cord sets to ease the cabling of CANopen devices within a cabinet.

These cord sets, together with the daisy-chain connector, release customer from mounting connectors manually. The in-cabinet cabling is based on RJ45 connectors. If every CANopen device used in the cabinet is equipped with an RJ45 connector, the network topology is a simple daisy chain without TAPs.

Example

The figure below provides an example of a CANopen cabling within a cabinet:



1 VW3 M3 805R010
2 VW3 CAN CARR03
3 TCSCTN023F13M03
4 VW3 CAN CARR01
5 TCSCAR013M120

Infrastructure Elements

The following infrastructure elements are provided for in-cabinet cabling:

Catalog No.	Element Type	Connector Type	Cable Length
VW3 CAN CARR03	preassembled cable	RJ45 at both ends	0.3 m (0.98 ft)
VW3 CAN CARR01	preassembled cable	RJ45 at both ends	1.0 m (3.28 ft)
VW3 M3 805R010	preassembled cable	1 RJ45 and 1 SUB-D9 with termination resistor	1.0 m (3.28 ft)
TCSCTN023F13M03	daisy-chain connector	1 RJ45 plug and 2 RJ45 sockets	–
TCSCAR013M120	–	RJ45 termination resistor	–
TCS CCN 4F3 M05T	preassembled cable	1 RJ45 and 1 SUB-D9 with termination resistor	0.5 m (1.64 ft)
TCS CCN 4F3 M1T	preassembled cable	1 RJ45 and 1 SUB-D9	1.0 m (3.28 ft)
TCS CCN 4F3 M3T	preassembled cable	1 RJ45 and 1 SUB-D9	3.0 m (9.84 ft)

Limitations

If you use 1 of these infrastructure elements in the trunk line, the following restrictions apply:

- The maximum cable length is reduced by 50% compared to a standard CANopen cable (refer to table Maximum Cable Length *(see page 28)* and table Maximum Cable Length vs. Number of Nodes *(see page 29)*).
- Use this in-cabinet cabling infrastructure elements only inside 1 single cabinet. To spread the CANopen network over several different cabinets, use standard CANopen cable (TSXCANCA•••, TSXCANCB•••, TSXCANCD•••) for connecting the cabinets.
- RJ45 connectors do not provide CAN_V+ and thus do not provide power distribution.

3.2 Physical Layer Limitations

Overview

This section lists the restrictions you must obey when setting up a CANopen network and includes a troubleshooting section to assist you in solving problems that may arise during installation.

What's in this Section?

This section contains the following topics:

Topic	Page
Transmission Speed and Cable Length	28
Drop Cable Limitations	30
Network with External Power Supply	32
Verifications and Troubleshooting	34

Transmission Speed and Cable Length

At a Glance

CANopen allows 127 devices (the bus master and 126 remote slaves). Transmission speed depends strictly on the type of used cable.

In the CAN protocol frame priority is managed by collision between dominant and recessive levels of the line. This collision must be resolved during transmission of a bit, which limits the signal propagation delay between 2 nodes.

The following tables specify the maximum trunk cable length based on the CANopen cable provided by Schneider Electric (TSXCANCA•••, TSXCANCB••• and TSXCANCD•••).

Maximum Cable Length

Consequently, the maximum distance between the 2 most distant nodes of a CAN bus depends on the speed and is provided in the following table:

Speed in bit/s	Maximum Cable Length
1 Mbit/s	20 m (65 ft)
800 kbit/s	40 m (131 ft)
500 kbit/s	100 m (328 ft)
250 kbit/s	250 m (820 ft)
125 kbit/s	500 m (1640 ft)
50 kbit/s	1000 m (3280 ft)
20 kbit/s	2500 m (8202 ft)
10 kbit/s	5000 m (16404 ft)

According to the Schneider Electric network strategy, the speeds 1 Mbit/s, 800 kbit/s, 500 kbit/s, 250 kbit/s and 125 kbit/s are recommended for automation solutions at machine and installation level.

NOTE: The maximum length assumes a reasonable device internal propagation delay and bit sampling point. Devices that present long internal propagation delays will effectively reduce the maximum cable length that could otherwise be realized.

The cable lengths of the above table may include a drop cable if it is at the physical end of the trunk cable.

Repeaters Reducing Cable Length

The above values specify the maximum cable length without any repeater. As repeaters add a propagation delay in the bus, this delay reduces the maximum length of the bus. A propagation delay of 5 ns leads to a length reduction of 1 m (3 ft).

Example. A repeater with a propagation delay of 150 ns reduces the maximum cable length by 30 m (98 ft).

Maximum Cable Length vs. Number of Nodes

In addition to the length limitations based on the transmission speed, the maximum cable length is also influenced by the load resistance.

In any case, the maximum number of nodes that may be connected on the same segment is restricted to 64. To connect more nodes to 1 segment, use a repeater.

The table below shows the influence by the number of nodes on the cable length:

Number of Nodes	Maximum Cable Length
2	229 m (751.31 ft)
16	210 m (688.97 ft)
32	195 m (639.76 ft)
64	170 m (557.74 ft)

Electrical Isolation of CANopen Devices

In documents about CANopen you will often find the value of 40 m (131 ft) maximum value at a transmission speed of 1 Mbit/s. This length is calculated without electrical isolation as used in the Schneider Electric CANopen devices.

With such electrical isolation the minimum network length calculated is 4 m (13 ft) at a transmission speed of 1 Mbit/s. However, the experience shows that 20 m (65 ft) are the practical length that could be shortened by drops or other influences.

Drop Cable Limitations

Overview

A drop cable creates a signal reflection on the transmission line characteristic of the trunk cable. In order to limit reflections, drop cables should be as short as possible.

Maximum Drop Cable Length

Respect the values listed in the following table:

Transmission Rate	Lmax	ΣLmax	TAP Distance	ΣLGmax
1 Mbit/s	0.3 m (0.98 ft)	0.6 m (0.98 ft)		1.5 m (4.92 ft)
800 kbit/s	3 m (9.84 ft)	6 m (19.68 ft)	3.6 m (11.81 ft)	15 m (49.21 ft)
500 kbit/s	5 m (16.4 ft)	10 m (32.8 ft)	6 m (19.68 ft)	30 m (98.42 ft)
250 kbit/s	5 m (16.4 ft)	10 m (32.8 ft)	6 m (19.68 ft)	60 m (196.84 ft)
125 kbit/s	5 m (16.4 ft)	10 m (32.8 ft)	6 m (19.68 ft)	120 m (393.69 ft)
50 kbit/s	60 m (196.84 ft)	120 m (393.69 ft)	72 m (236.21 ft)	300 m (984.24 ft)
20 kbit/s	150 m (492.12 ft)	300 m (984.24 ft)	180 m (590.54 ft)	750 m (2460.62 ft)
10 kbit/s	300 m (984.24 ft)	600 m (1968.49 ft)	360 m (1181.09 ft)	1500 m (4921.24 ft)

Lmax is the maximum length of 1 drop cable.

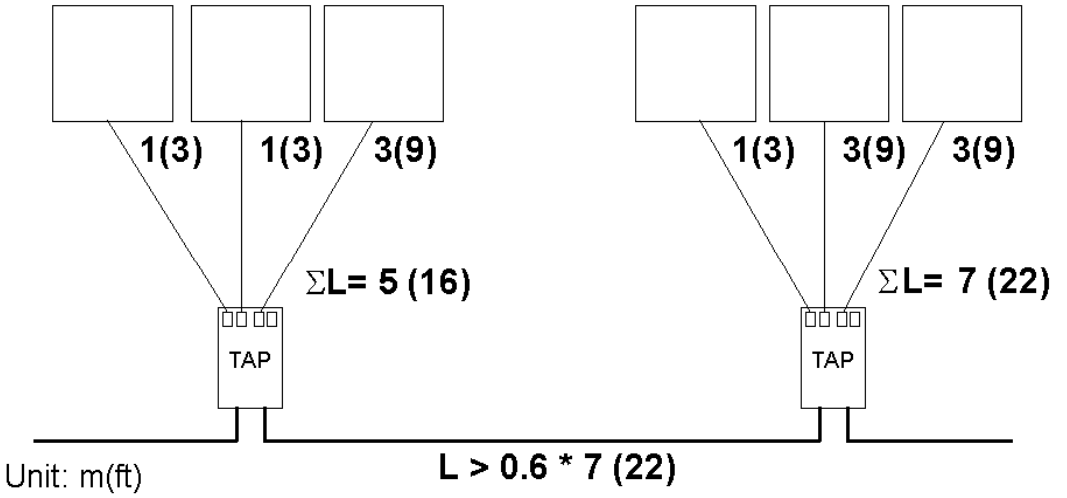
Σ**Lmax** is the maximum value of the sum of drop cables on the same TAP.

TAP distance is the minimum distance necessary between 2 TAPs, can be calculated for each TAP (must be greater than 60% of the largest of the 2 ΣLmax).

Σ**LGmax** is the maximum value of the sum of drop cables on the network.

Calculation Example

The figure below provides an example of a TAP distance calculation with 2 junction boxes and 6 devices:



The TAP distance in the above example is calculated as follows:

Step	Description	Result
1	Calculating the sum of lengths of drop cables for each tap junction.	5 m (16 ft) and 7 m (22 ft)
2	Keeping the longest length.	7 m (22 ft)
3	Calculating the minimum cable length between the 2 TAPs.	60% of 7 m (22 ft)

Respect the TAP distance even if a device is in between.

Network with External Power Supply

Basic Characteristics

The rated voltage of the power supply shall be 24 V.

The sum current drawn by the powered devices from 1 power supply shall not exceed 1500 mA. This also applies to a single device.

Selecting a Power Supply

The following table lists the requirements the power supply should meet:

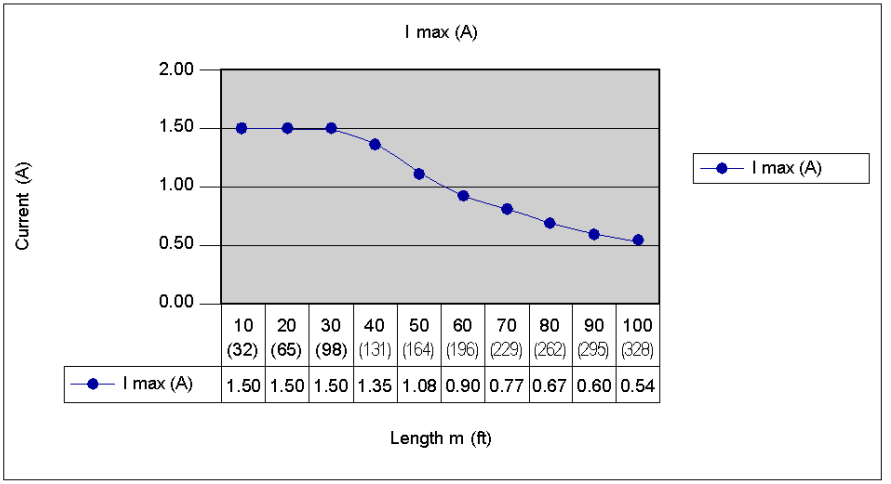
Standard	IEC61131-2:2003, PELV or SELV
Initial tolerance	24 V +/- 3% or better (no load voltage)
Line regulation	+/- 3% max
Load regulation	+/- 3% max
Output ripple	200 mV p-p max
Load capacitance capability	7000 µF max
Isolation	output isolated from AC and chassis ground
Minimum output voltage	19.2 V at full load
Current limit	2 A

It is recommended to use Schneider Electric power supplies from the Phaseo product family such as ABL-7RE2402 or ABL-7CEM24••.

Cable Length Limitation

Based on the amount of current, a certain voltage drop over the cable will appear. This voltage drop - and thus the cable length - needs to be limited.

The figure below illustrates the limits you must respect for the recommended cable TSXCANCA••• / TSXCANCB••• / TSXCANCD•••:



	10 (32)	20 (65)	30 (98)	40 (131)	50 (164)	60 (196)	70 (229)	80 (262)	90 (295)	100 (328)
I max (A)	1.50	1.50	1.50	1.35	1.08	0.90	0.77	0.67	0.60	0.54

Verifications and Troubleshooting

Overview

For reliable CANopen network communications perform the verifications described in the following.

Verifying the Device Configuration

Perform the following steps to verify the configuration of your devices:

Step	Action
1	Verify that the connected devices are configured to the same transmission speed.
2	Verify that each device has a unique node address.

Verifying the Topology

Perform the following steps to verify the topology of your CANopen network:

Step	Action
1	Verify the maximum cable length versus transmission speed.
2	Verify the length of the segment and the number of nodes on the segment.
3	Verify the length of drop cables and TAP distance versus transmission speed.

Verifying the Wiring

Perform the following steps to verify the wiring only with the devices being switched off or being disconnected from the network:

Step	Action
1	Verify the resistance between `CAN_L` and `CAN_H`: • if R > 65 Ω the reason may be a missing termination resistor or a broken wire • if R < 50 Ω the reason may be a redundant termination resistor or a short circuit between `CAN` signals
2	Verify that no short circuits exist between `CAN_L` or `CAN_H` signals and `CAN_GND`, `CAN_V+` signals and the shield.

To perform these measurements use a standard multimeter or, more comfortably, an installation tester, e.g. CANcheck from IXXAT.

CANopen Infrastructure Components

4

Subject of This Chapter

This chapter describes the standard CANopen infrastructure components provided by Schneider Electric.

For a complete list of all infrastructure components available refer to the Schneider Electric *CANopen Catalog* (part 4 of the catalog *Machines & Installations with industrial communications*).

What's in this Chapter?

This chapter contains the following sections:

Section	Topic	Page
4.1	CANopen Cables	36
4.2	CANopen Cable Connectors	39
4.3	CANopen TAPs	48
4.4	CANopen - Daisy Chain Connector	55
4.5	Preassembled Cord Sets	57

4.1 CANopen Cables

Overview

This section lists the characteristics of CANopen cables.

What's in this Section?

This section contains the following topics:

Topic	Page
CANopen Cables	37
Cable Types	38

CANopen Cables

Overview

Schneider Electric provides 1 cable type that performs the following functions:

- trunk
- drop
- power distribution over the network

The CANopen cable provides 2 twisted pairs. Each pair has a separate shield to reduce the disturbances from the power wires to the CANopen signal wires. Both pairs are shielded with a common tinned copper braid and an additional drain wire.

Wire Pair Characteristics

The following table lists the characteristics of the individual wire pairs of a CANopen cable:

Wire	Characteristic	Signal	Color
Pair A	conductor gauge: 0.34 mm^2 (AWG 22)	CAN_V+	red
Pair A	linear resistance: 55 Ω/km	CAN_GND	black
Pair B	conductor gauge: 0.2 mm^2 (AWG 24)	CAN_H	white
Pair B	linear resistance: 90 Ω/km	CAN_L	blue
Pair B	characteristic impedance: 120 Ω	–	–

General Cable Characteristics

The following table lists the general characteristics of CANopen cables:

Shield	tinned copper braid and drain wire
Sheath color	Magenta RAL 4001
Operating temperature	-10° –+80° C (14° –176° F)
Storage temperature	-25° –+80° C (-13° –176° F)
Overall diameter	7.4 (0.29 in.) ± 0.2 mm (0.007 in.)

Cable Types

Available Cables

Schneider Electric provides 3 different types of cable that differ in their sheath characteristic:

- TSXCANCA••• is dedicated to the European market, LSZH (low smoke zero halogen)
- TSXCANCB••• is dedicated to the American market, UL and CSA certified, fire retarding
- TSXCANCD••• is a flexible cable for severe environments, very good chemical resistance to oil and grease, LSZH and ready for mobile applications

Each cable type is available in lengths of 50 m (164 ft), 100 m (328 ft) or 300 m (984 ft).

Specific Cable Characteristics

The Schneider Electric cables have the following characteristics:

Characteristics	**TSXCANCA**	**TSXCANCB**	**TSXCANCD**
Minimum curve radius - fixed applications	67 mm (2.63 in.)	67 mm (2.63 in.)	37 mm (1.45 in.)
Minimum curve radius - mobile applications	–	–	74 mm (2.91 in.)
Fire retardant	IEC 60332-1	IEC 60332-3	IEC 60332-1
Oil resistant	–	–	VDE 0472 part 803B
Low smoke	VDE 0207-24	–	VDE 0207-24
Zero halogen	EN50290-2-27	–	EN50290-2-27
Track chain application			
Maximum number of cycles	–	–	1,000,000
Maximum acceleration	–	–	5 m/s^2 (16.4 ft/s^2)
Speed	–	–	200 m/mn (656 ft/mn)
Alternative flection			
Bending angle	–	–	180°
Maximum cycles	–	–	30,000
Maximum wheel diameter	–	–	200 mm (7.87 in.)

4.2 CANopen Cable Connectors

Overview

This section provides an overview of the different CANopen cable connectors.

What's in this Section?

This section contains the following topics:

Topic	Page
SUB-D 9 Cable Connectors	40
Open Style Cable Connectors	44
IP67 M12 Cable Connector	46

SUB-D 9 Cable Connectors

Connector Types

Schneider Electric provides the following types of SUB-D 9 cable connectors:

Schneider Electric Cable Connector	Characteristics
TSXCANKCDF90T	90° cable
TSXCANKCDF180T	180° cable
TSXCANKCDF90TP	• 90° lead • male connector available for temporary connection of a diagnostic tool

Common Functions

The above mentioned connector types have the following functions in common:

- connection of 1 or 2 cables on screw terminals (a wire terminal)
- shield interconnection of the 2 cables and the connector's metal housing
- integrated termination resistor, switchable with an ON/OFF switch

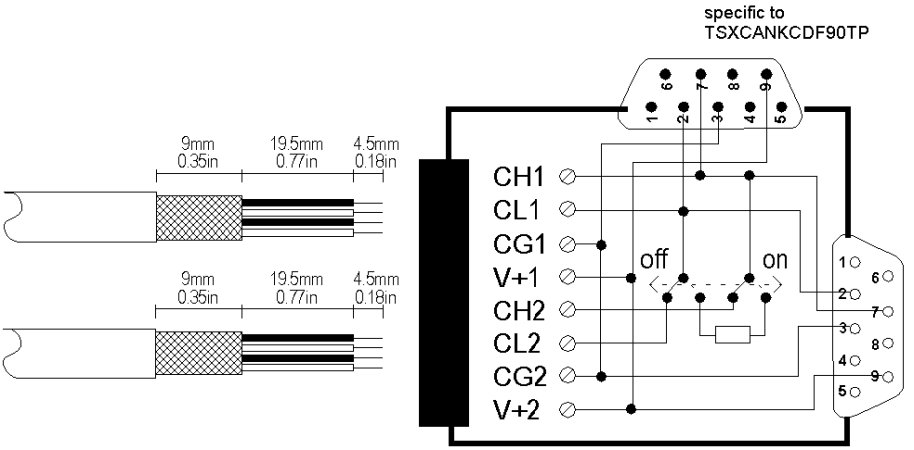
Chaining Function

The cable connectors may be used for chaining cables between CANopen devices:

If...	Then ...
the device is at the beginning or at the end of the network	the cable is connected on the terminal block 1 (incoming cable) and the line termination switch is ON.
the device is in the middle of the bus	2 cables are interconnected in the connector and line termination switch is OFF.

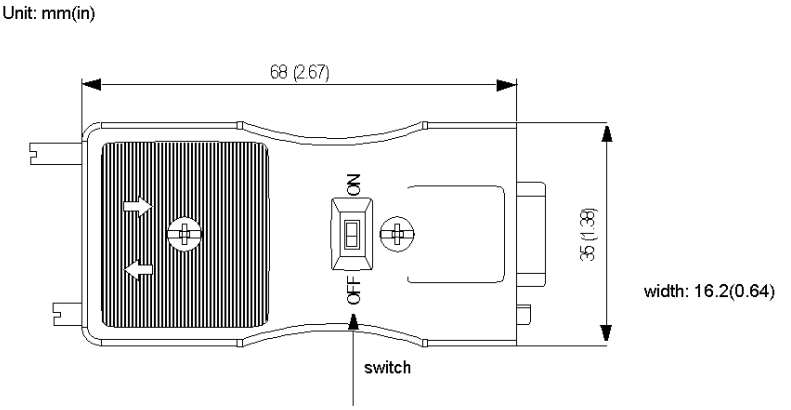
Wiring

The figure below shows the wiring of TSXCANKCDF90T, TSXCANKCDF180T and TSXCANKCDF90TP:



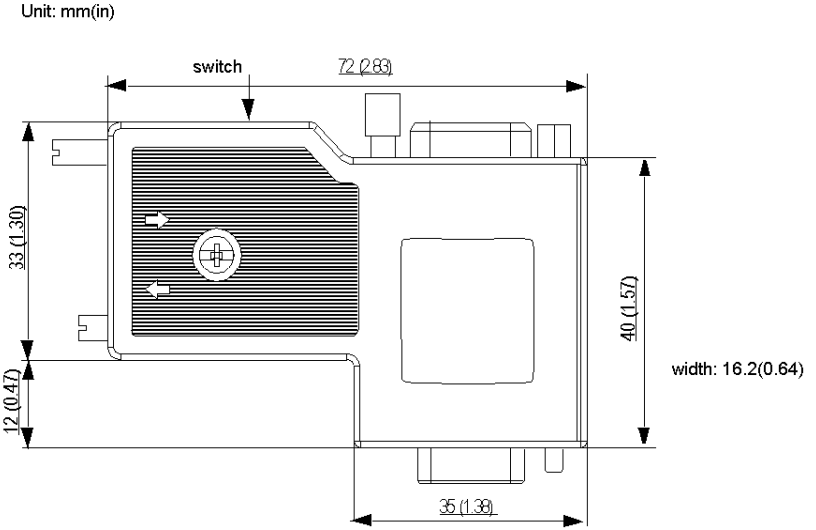
TSXCANKCDF180T

The figure below shows the TSXCANKCDF180T cable connector:



TSXCANKCDF90T / TSXCANKCDF90TP

The figure below shows the dimensions of the TSXCANKCDF90T / TSXCANKCDF90TP cable connector:



Connections

⚠ CAUTION

CANopen NETWORK MALFUNCTION

The `CAN_V+` signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

Failure to follow these instructions can result in injury or equipment damage.

When you use the Schneider Electric standard CANopen cable (TSXCANCA•••, TSXCANCB••• or TSXCANCD•••) you must comply with the wiring combinations (signal, wire color) described in the table below.

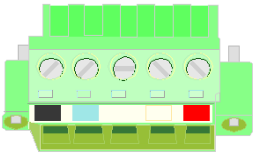
The following table shows terminal block wiring depending on the signal:

Signal	**Terminal Block 1, Incoming Cable**	**Terminal Block 2, Outgoing Cable**	**Wire Color**
CAN_H	CH1	CH2	white
CAN_L	CL1	CL2	blue
CAN_GND	CG1	CG2	black
CAN_V+	V+1	V+2	red

Open Style Cable Connectors

Illustration

The figure below shows the open style cable connector:



Wiring Information

⚠ CAUTION

CANopen NETWORK MALFUNCTION

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

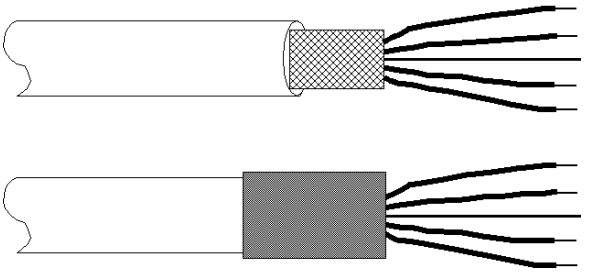
Failure to follow these instructions can result in injury or equipment damage.

Pin	Signal	Connector Color Marking	Wire Color	Termination Resistor
1	CAN_GND	black	black	place a 120 Ω 0.25 W 5% resistor between CAN_H and CAN_L if this is the physical end of the trunk cable
2	CAN_L	blue	blue	
3	CAN_Shield	bare	tinned copper drain wire	
4	CAN_H	white	white	
5	CAN_V+	red	blue	

Cable Preparations

Prepare your cable for connection to an open style connector as follows:

Step	Action
1	Strip the sheath from the end of the cable.
2	Remove copper braided shield thereby keeping the drain wire.
3	Wrap the end of the cable with shrink wrap.



IP67 M12 Cable Connector

Connector Types

Schneider Electric provides 2 types of IP67 M12 connectors:

male	FTX CN 12M5
female	FTX CN 12F5

Chaining

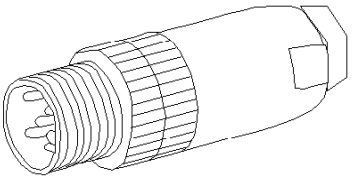
Since these connectors allow to connect only 1 cable the chaining of the cable is performed by the device. It provides specific ports for the incoming and outgoing cable.

The incoming cable is connected to the BUS IN port of the device.

The outgoing cable is connected to the BUS OUT port of the device.

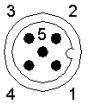
Illustration

The figure below shows an IP 67 M12 cable connector:



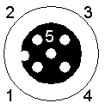
BUS IN Connector

The figure below shows the 5-pin M12 male BUS IN connector:



BUS OUT Connector

The figure below shows the 5-pin M12 female BUS OUT connector:



Pin Assignment

⚠ CAUTION

CANopen NETWORK MALFUNCTION

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

Failure to follow these instructions can result in injury or equipment damage.

The following table shows the pin assignments of the BUS IN and BUS OUT connector pins:

Pin	Signal	Meaning
1	(CAN_SHLD)	optional CAN shielding
2	(CAN_V+)	optional positive power supply
3	CAN_GND	0 V
4	CAN_H	CAN_H bus line
5	CAN_L	CAN_L bus line

4.3 CANopen TAPs

Overview

This section provides an overview of the different CANopen TAPs.

What's in this Section?

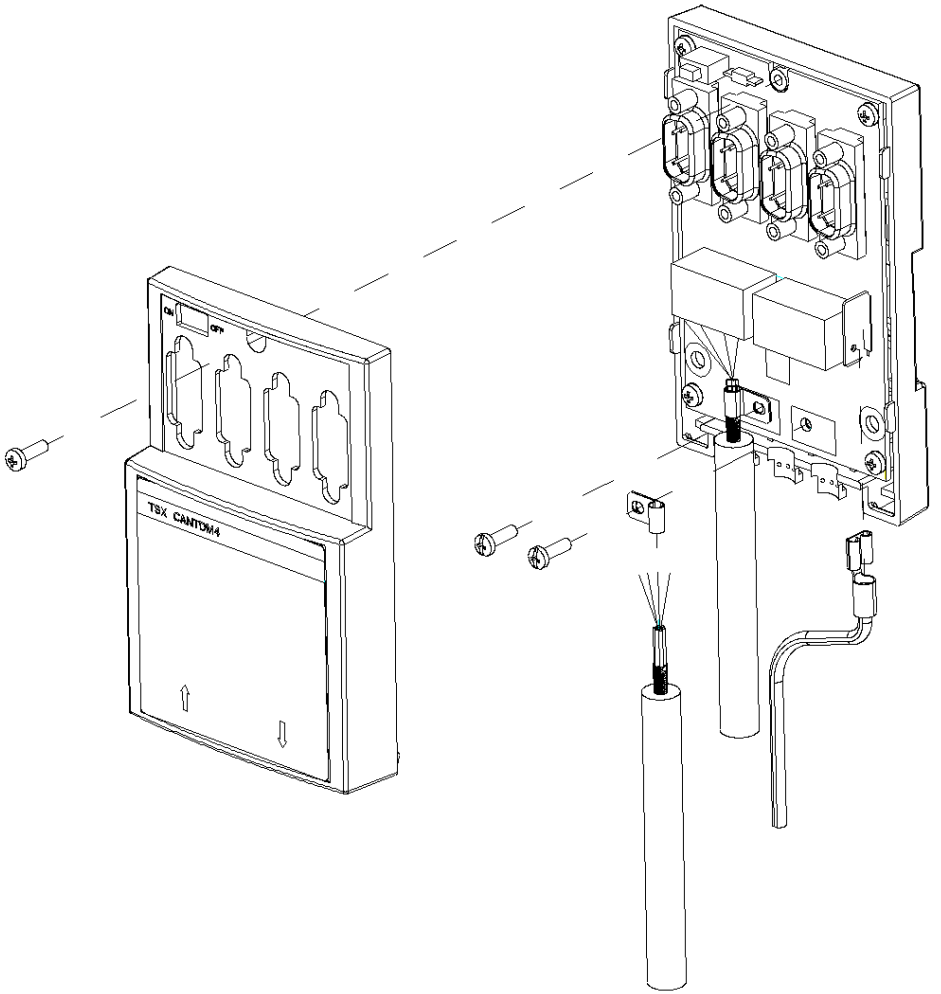
This section contains the following topics:

Topic	Page
TSX CAN TDM4	49
VW3 CAN TAP2	53

TSX CAN TDM4

Overview

The TSX CAN TDM4 TAP allows connection of 4 devices by branching the drop cable to the four male SUB-D 9 plugs.



Wiring

CAN signals (CAN_H, CAN_L, CAN_GND, and CAN_V+) from incoming and outgoing cables and the four SUB-D 9 are interconnected inside the box. Similarly, the connector shield is connected to the cable shield. Connection to the PE terminal (ground) must use the green-yellow cable.

Attachment

The TSX CAN TDM4 TAP may be screwed onto a plate or snapped on a DIN rail.

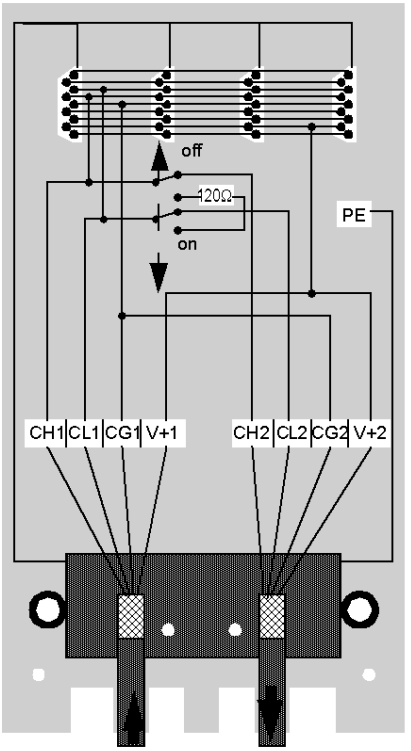
Grounding

In addition to using the DIN rail ground, the TSX CAN TDM4 may be grounded using the terminal marked PE in the box by using a short cable (cable cross-section of 2.5 mm^2 (AWG13) or more).

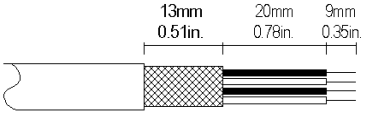
Line Termination Switch

A line termination switch is is provided to switch a built-in termination resistor. If the line termination switch is switched OFF, the signals CAN_H and CAN_L of the outgoing cable are disconnected.

View of the TSX CAN TDM4 with line termination switch



Cable preparation template



Wiring

⚠ CAUTION

CANopen NETWORK MALFUNCTION

The `CAN_V+` signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

Failure to follow these instructions can result in injury or equipment damage.

The following table shows terminal block wiring depending on the signal:

Signal	Terminal Block 1	Terminal Block 2	Wire Color
CAN_H	CH1	CH2	white
CAN_L	CL1	CL2	blue
CAN_GND	CG1	CG2	black
CAN_V+	V+1	V+2	red

VW3 CAN TAP2

Overview

The VW3 CAN TAP2 allows connection of 2 devices like ATV31, ATV71, Lexium05 by branching the drop cable to the 2 connectors S1 and S2. It additionally allows the connection of a Modbus-based tool on connector S3.

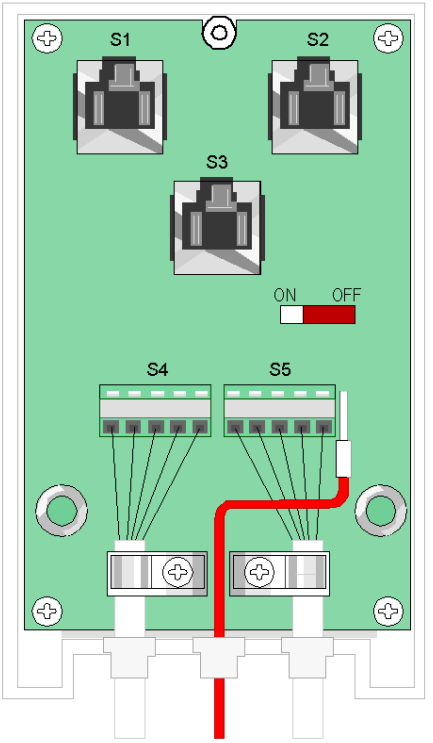
Wiring

CAN signals (CAN_H, CAN_L, and CAN_GND) from incoming and outgoing cables and the 2 RJ45 connectors (S1, S2) are interconnected inside the box. Similarly, connector shield is connected to the cable shield. Connection to the PE terminal (ground) must use the green-yellow cable.

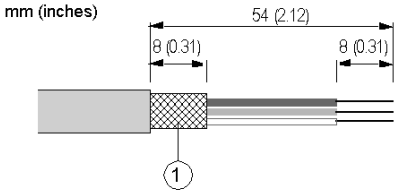
Line Termination Switch

A line termination switch is provided to switch a built-in termination resistor.

View of the VW3 CAN TAP2 with line termination switch



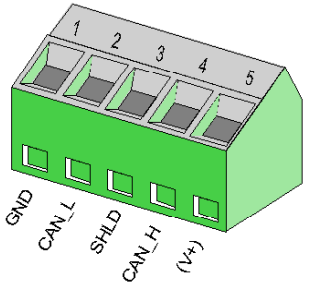
Cable preparation template



1 shielding

Pin Assignment

The figure below shows an S4/S5 connector:



⚠ CAUTION

CANopen NETWORK MALFUNCTION

The V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following table.

Failure to follow these instructions can result in injury or equipment damage.

The following table shows pin assignment together with the color of the wire:

Pin	Signal	Wire Color	Description
1	GND	black	ground
2	CAN_L	blue	CAN_L bus line
3	SHLD	(bare cableshield)	optional shield
4	CAN_H	white	CAN_H bus line
5	(V+)	red	optional positive power supply

4.4 CANopen - Daisy Chain Connector

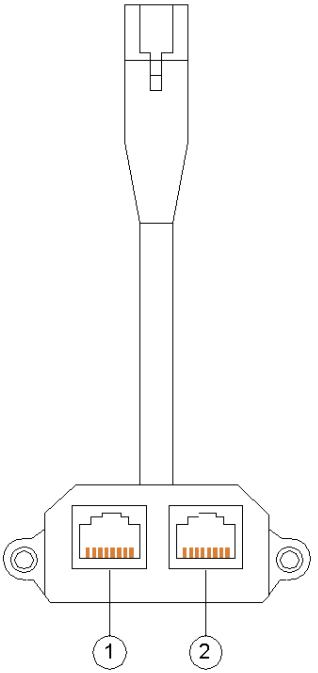
CANopen - Daisy Chain Connector

Overview

The TCSCTN023F13M03 provides a Y-junction for RJ45 connectors, thus allowing to daisy chain the CAN cable.

Mechanical View

The figure below shows the mechanical view of the daisy chain connector:

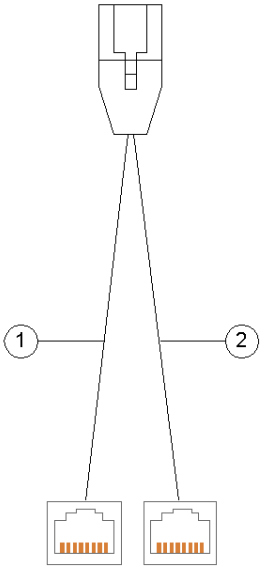


1 in connector
2 out connector

Even though the visible cable length of this connector is 0.30 m (0.98 ft) you must consider an absolute length of 0.60 m (1.97 ft) when calculating the maximum cable length due to its electrical wiring (see figure below).

Electrical Wiring

The figure below shows the electrical wiring of the daisy chain connector:



1 CAN_H, CAN_L, CAN_GND
2 CAN_H, CAN_L, CAN_GND

4.5 Preassembled Cord Sets

Preassembled Cord Sets

Overview

Schneider Electric offers several preassembled cord sets for easy CANopen cabling for IP20 and IP67 environments.

Design

Those cord sets consist of a cable with certain length and ready-mounted connectors. The CAN signals (CAN_H, CAN_L, CAN_GND, CAN_V+) and the cable shield are wired through the cables.

For a complete list of preassembled cord sets refer to the Schneider Electric CANopen catalog.

CANopen - Connectors

5

CANopen Device Connector Pinout

Overview

Schneider Electric devices are equipped with the following types of CANopen connectors:

- SUB-D 9
- open style
- IP67 M12
- RJ45 connector

⚠ CAUTION

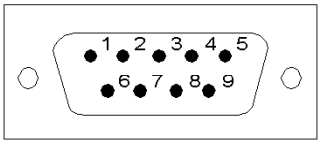
CANopen NETWORK MALFUNCTION

The CAN_V+ signal (red wire) must only be used for power distribution. The wiring connections must comply with the combinations described in the following tables.

Failure to follow these instructions can result in injury or equipment damage.

SUB-D 9 Connector

The figure below shows the male SUB-D 9 connector:



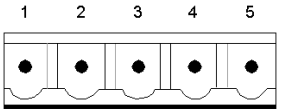
The following table shows the pin assignments of the SUB-D 9 connector:

Pin	Signal	Meaning
1	–	reserved
2	CAN_L	CAN_L bus line
3	CAN_GND	CAN ground

Pin	Signal	Meaning
4	–	reserved
5	(CAN_SHLD)	optional CAN shield
6	GND	ground, connection to pin 3
7	CAN_H	CAN_H bus line
8	–	reserved
9	(CAN_V+)	optional external positive supply

Open Style Connector

The figure below shows the open style device connector:



The following table shows the pin assignments of the open style device connector:

Pin	Signal	Meaning
1	CAN_GND	CAN ground
2	CAN_L	CAN_L bus line
3	CAN_Shield	CAN_Shield
4	CAN_H	CAN_H bus line
5	(CAN_V+)	optional external positive supply

IP67 M12 Connector

For the pinout of the IP67 M12 connector refer to IP67 M12 Connector *(see page 46)*.

RJ45 Connector

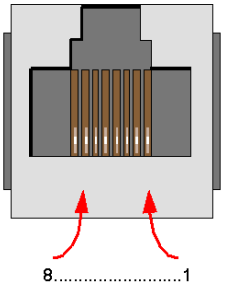
Schneider Electric provides CANopen devices with 1 RJ45 connector or with 2 RJ45 connectors.

The devices with 2 connectors allow an easy daisy chaining of the CAN, because the 2 connectors are internally connected.

For devices with 1 RJ45 connector (like ATV31, ATV71, Lexium05) the following adapters are required:

Catalog No.	Adapter Type
VW3 CAN A71	adapting the ATV71 to SUB-D9
VW3 CAN TAP2	TAP allowing to connect 2 drop cables
TCSCTN023F13M03	daisy chain connector

The figure below shows the RJ45 connector:

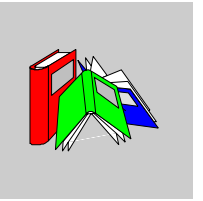


The following table shows the pin assignments of the RJ45 connector:

Pin	Signal	Meaning
1	CAN_H	CAN_H bus line
2	CAN_L	CAN_L bus line
3	CAN_GND	CAN ground
4	D1*	Modbus signal
5	D0*	Modbus signal
6	not connected	–
7	VP*	supply for RS323/RS485 converter or remote terminal
8	Common*	Modbus common

* These signals are provided by ATV31, ATV71, Lexium05 and VW CAN TAP2 only. Otherwise the according pins are not connected.

Glossary



C

cable connector

the part of a connector mounted on the cable. A cable connector may provide the connection of 2 cables for chaining. A cable connector may include the termination resistor.

CAN

Controller Area Network: field bus originally developed for automobile applications which is now used in many sectors, from industrial to tertiary

CANopen

CANopen specifies the higher layer protocol and is based on CAN

D

drop cable

unterminated derivation cord used for connection between TAP and device

L

LT

Line Termination: termination of the trunk cable with 120 Ω resistor, the resistor may be integrated in the TAP or in the cable connector

T

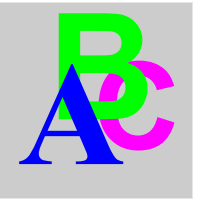
TAP

Terminal Access Point: junction box connected to the trunk cable, allows to plug some drop cables

trunk cable

the main cable terminated at both physical ends with line termination resistors.

Index



A

architecture, *12*

B

bridge
    architecture, *16*

C

cable, *32*
cable characteristics, *37*
cable connectors
    IP67 M12, *46*
    open style, *44*
    SUB-D 9, *40*
cable types, *38*
cables, *24*
cabling
    in-cabinet, *25*
CANopen
    principles, *9*
connectors
    pinout, *59*
cord sets, *57*

D

daisy chain connectors, *55*
device connectors, *59*
drop cables, *30*

E

external power supply, *32*

I

in-cabinet cabling, *25*
installing
    cables, *24*
IP67 M12 connectors, *46*

M

M12 connectors, *46*

O

open style connectors, *44*

P

Phaseo, *32*
pinout, *59*
power supplies, *32*

R

repeater
    architecture, *14*

S

SUB-D 9 cable connectors, *40*

T

TAP
    architecture, *17*
topology, *12*
    basic, *13*
    bridge, *16*
    cascading TAPs, *17*
    network with external power supply, *18*
    repeater, *14*
troubleshooting, *34*
TSX CAN TDM4, *50*

V

VW3 CAN TAP2, *53*